EXHAUSTING MECHANISM FOR CVD EQUIPMENT

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Abstract of **JP2125876**

PURPOSE:To remove a residual product formed in high-frequency washing of the inside of an exhaust pipe and to prevent generation of dust by constituting the exhaust pipe of a reaction chamber of a microwave waveguide with a magnetron connected to the terminal part thereof and providing both a heating means and an exhausting means thereto. CONSTITUTION:The reactive gas consisting of gaseous substance is made solid substance by chemical reaction in a reaction chamber 1 and this solid substance is deposited on a base plate 5 to be treated which has been regulated to the prescribed temp. by a heater 3 and a thin film is formed. The residual gas after reaction in the above CVD equipment is discharged to the outside of the reaction chamber 1 via a waveguide 11 successively provided to the bottom part of the reaction chamber 1 by an exhausting means 16 consisting of an exhaust pipe 16a and an exhaust pump 16b. In the above exhausting mechanism, both a heating means 13 and a magnetron 14 are provided to the waveguide 11. The residual product formed in the case of performing high-frequency washing of the inside of the reaction chamber 1 is heated and also activated by plasma resulting from microwave and allowed to react with gaseous O2 to form a film and thereby formation of fine dust is prevented. Furthermore etching gas such as NF3 and HCl is introduced and the above thin film is removed.

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⑭発明の名称　ＣＶＤ装置の排気機構

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明　細　書

1.　発明の名称

ＣＶＤ装置の排気機構

2.　特許請求の範囲

（１）反応室(1)内でガス状物質を化学反応で固体物質にし、被処理基板(5)に薄膜状に堆積し、前記化学反応後の残留ガスを前記反応室(1)外に排出するＣＶＤ装置の排気機構において、

前記反応室(1)の室壁を貫通し、前記反応室(1)外に導出されたマイクロ波用の導波管(11)と、

該導波管(11)を加熱する加熱手段(13)と、

前記反応室(1)外の前記導波管(11)の終端部に接続されるマグネトロン(10)と、

前記導波管(11)に結合される排気手段(19)とから構成されてなることを特徴とするＣＶＤ装置の排気機構。

（２）前記導波管(11)に設けた酸素ガスまたはエッチングガスのガス選択注入手段(17)を有することを特徴とする特許請求の範囲第（１）項記載のＣＶＤ装置の排気機構。

3.　発明の詳細な説明

〔概　要〕

ＣＶＤ装置に係り、特に反応炉内における化学反応後のガスの排気機構に関し、

排気管内の高周波洗浄による残留生成物の除去が可能なＣＶＤ装置の排気機構の提供を目的とし、

反応室内でガス状物質を化学反応で固体物質にし、被処理基板(5)に薄膜状に堆積し、前記化学反応後の残留ガスを前記反応室外に排出するＣＶＤ装置の排気機構において、前記反応室の室壁を貫通し、前記反応室外に導出されたマイクロ波用の導波管と、該導波管(11)を加熱する加熱手段と、前記反応室外の前記導波管の終端部に接続されるマグネトロンと、前記導波管に結合される排気手段とから構成する。

〔産業上の利用分野〕

本発明は、ＣＶＤ装置に係り、特に反応炉内に

おける化学反応後のガスの排気機構に関する。

〔従来の技術〕

従来薄膜の形成方法として半導体工業において一般に広く用いられているものの一つに化学気相成長法(CVD；Chemical Vapour Deposition)がある。このCVD装置等の半導体製造装置において、被処理基板に対して所定の薄膜等の成長を終了した後に、反応室内に生成される残留生成物の剥離除去のために三弗化窒素(NF_3)ガス、あるいは四弗化炭素(CF_4)ガスと酸素(O_2)の混合ガス等のエッチングガスの雰囲気内で高周波発振器によるプラズマ発生を利用した高周波洗浄の方法が用いられている。通常このような三弗化窒素ガス等による高周波洗浄のサイクル時間は、例えば薄膜の成長時間1時間に対して高周波洗浄も約1時間行う方法が用いられている。

第2図は従来のCVD装置の要部断面図を示す。図において、1は反応室であってステンレス部材の容器で構成され、その底部には排気口2が設けられ、この排気口2は図示しない排気管を介して排気ポンプに連結されている。3はヒータ、4は回転自在に設けられたウエハーサセプタであって複数の被処理基板5を搭載できる。

6は反応ガス導入管であって、被処理基板5の載置可能数に対応して設けられ、各バルブ6a～6eを介してそれぞれ三弗化窒素(NF_3)，酸素(O_2)，窒素(N_2)，フォスフィン(PH_3)，シラン(SiH_4)等のガスが導入される。反応ガス導入管6はアルミ材で形成されたガス吹出盤7に連結され、その反応ガス導入管6とガス吹出盤7とは反応室1に対してアルミナ製の絶縁台8で絶縁されており、ガス吹出盤7とウエハーサセプタ4との間隔は、絶縁台8の厚み調整によって所定値に保持されている。

高周波洗浄に際しては、図示しない高周波発振器の出力はウエハーサセプタ4とガス吹出盤7すなわち電気的に接続された反応ガス導入管6とをそれぞれ電極として印加される。

8は多数のノズルを管壁に配設したリング状のシャワー管であって、矢印に示す方向に霧状に噴射する機能を有し、シャワー導入管9とバルブ9a～9cに連結され、高周波洗浄後に窒素ガスN_2，弗酸水溶液，アンモニア水溶液等がヒータ10にて加熱され、ノズルから噴射されることにより反応室内を洗浄する手段として知られたものである。

〔発明が解決しようとする課題〕

従来の高周波洗浄においては、排気口2の内壁面の黒点表示領域等に高周波洗浄後もかなりの生成物が付着したまま残留し、パーティクル（微小粉塵）発生原因となり、反応室に置かれた被処理基板（ウエハ等）の粒子汚染の主原因となる欠点がある。

また、排気口2の管内に電極を設けることはガスの排気通路を妨害する構造物の配置が必要となり、好ましくない問題がある。

この残留生成物を剥離除去するには長時間を必要とするため、装置稼動率が低下するといった問題があった。

本発明は、上記従来の欠点に鑑みてなされたもので、排気管内の高周波洗浄による残留生成物の除去が可能なCVD装置の排気機構の提供を目的とする。

〔課題を解決するための手段〕

第1図は、本発明の実施例の構成を示す要部断面図である。反応室1内でガス状物質を化学反応で固体物質にし、被処理基板5に薄膜状に堆積し、前記化学反応後の残留ガスを前記反応室1外に排出するCVD装置の排気機構において、前記反応室1の室壁を貫通し、前記反応室1外に導出されたマイクロ波用の導波管11と、該導波管11を加熱する加熱手段13と、前記反応室1外の前記導波管11の終端部に接続されるマグネトロン14と、前記導波管11に結合される排気手段16とから構成され、酸素ガスまたはエッチングガスを前記導波管11に設けたガス選択注入手段(17)から導入する。

〔作　用〕

反応室1を貫通して設けられたマイクロ波用の

導波管11は整合器15の作用によりマグネトロン14から出力されるマイクロ波を送出することができる。また排気手段16を構成する排気管16ａと排気ポンプ16ｂの作用により反応室１内における化学反応後の残留ガスを導波管11内を通して吸引する結果、これにガス注入手段により酸素ガスを加え、加熱手段13の加熱効果と共に残留ガスの活性化を促進し、導波管11の管内でマイクロ波によるプラズマ発生を利用して再度化学反応を発生させ、導波管11の管内壁面に薄膜状に堆積し、粉末化を防止する。また、内壁面に堆積した薄膜を剥離する場合は弗化物ガス(NF_3,CF_4)、あるいは塩化物ガス（$HC\ell$，$PC\ell_3$）等のエッチングガスをガス注入手段から注入すると共にマイクロ波によるプラズマ発生を利用して除去可能となる。

〔実施例〕

以下本発明の実施例を図面によって詳述する。なお、構成、動作の説明を理解し易くするために全図を通じて同一部分には同一符号を付してその

重複説明を省略する。

第１図は、本発明の実施例の構成を示す要部断面図である。図において、11はマイクロ波用の導波管であって、反応室１の底面の室壁を貫通して室外に導出され、その室外の導出部には反応室内側と導波管側との負荷整合を行うためのインピーダンス整合手段が設けられている。例えば伝送インピーダンスが75Ωの導波管11の負荷側端部を開放状態とするならば 300Ω／75Ωの整合比率に調整する。

13は導波管11の外部から内部を通過するガスを加熱するための加熱手段で、例えば電熱線等を巻回して用いる。14は導波管11の端部に接続されたマグネトロンであり、15はそのマグネトロン14と導波管11の整合をとる整合器である。前記インピーダンス整合手段と整合器15の併用によってマグネトロン14から出力されるマイクロ波は効率よく反応室１内に伝送される。

16は加熱手段13のマグネトロン14側の端部と整合器15との間の導波管11に結合される排気手段で

あって、排気管16ａと排気ポンプ16ｂとから構成され、導波管11の断面が方形の場合には幅の狭い方の面に排気管16ａを結合し、導波管11内のガスを排気管16ａを介して排気ポンプ16ｂにより吸引可能に配設する。

17は導波管11に分散配置されたガス選択注入手段であって、複数のガス注入管17ａ，17ｂ，17ｃとガスの選択を可能にする複数のバルブ17ｄ，17ｅ，17ｆとそれらを連結するパイプとから構成されている。

加熱手段13と、マグネトロン14と、排気ポンプ16ｂとを同時に駆動し、反応室１内の化学反応後の残留ガスを導波管11内に吸引し、ガス注入管17ａ～17ｃからバルブ17ｄを開放して酸素ガスを注入すると、前記残留ガスは加熱効果とマイクロ波によるプラズマ発生で活性化され、酸素ガスと再び化学反応を発生して導波管11の管内壁に薄膜が形成され、粉末化は防止される。導波管11の管内は完全な中空であり、ガスの通過を妨害する要因となるものは存在しないため効率よく薄膜付着さ

せることができる。

導波管11の管内壁に付着した薄膜はエッチングガスとなる弗化物ガス(NF_3,CF_4)、あるいは塩化物ガス（$HC\ell$，$PC\ell_3$）等をバルブ17ｅ，17ｆを選択操作してガス注入管17ａ～17ｃから注入すると共に、加熱手段13と、マグネトロン14と、排気ポンプ16ｂとを同時に駆動することにより薄膜は剥離できる。

整合器15の接続位置および排気管16ａの導波管11に対する結合位置の指定はマグネトロン14側に生成物が付着して整合器の動作を妨害することを避ける目的のためである。

〔発明の効果〕

以上の説明から明らかなように本発明によれば、被処理基板に対する粒子汚染の影響を大幅に軽減することができるという効果がある。

4. 図面の簡単な説明

第１図は本発明の実施例の構成を示す要部断面

図、

第２図は従来のＣＶＤ装置の要部断面図を示す。

第１図において、１は反応室、５は被処理基板、11は導波管、12はインピーダンス整合手段、13は加熱手段、14はマグネトロン、15は整合器、16は排気手段17はガス選択注入手段をそれぞれ示す。

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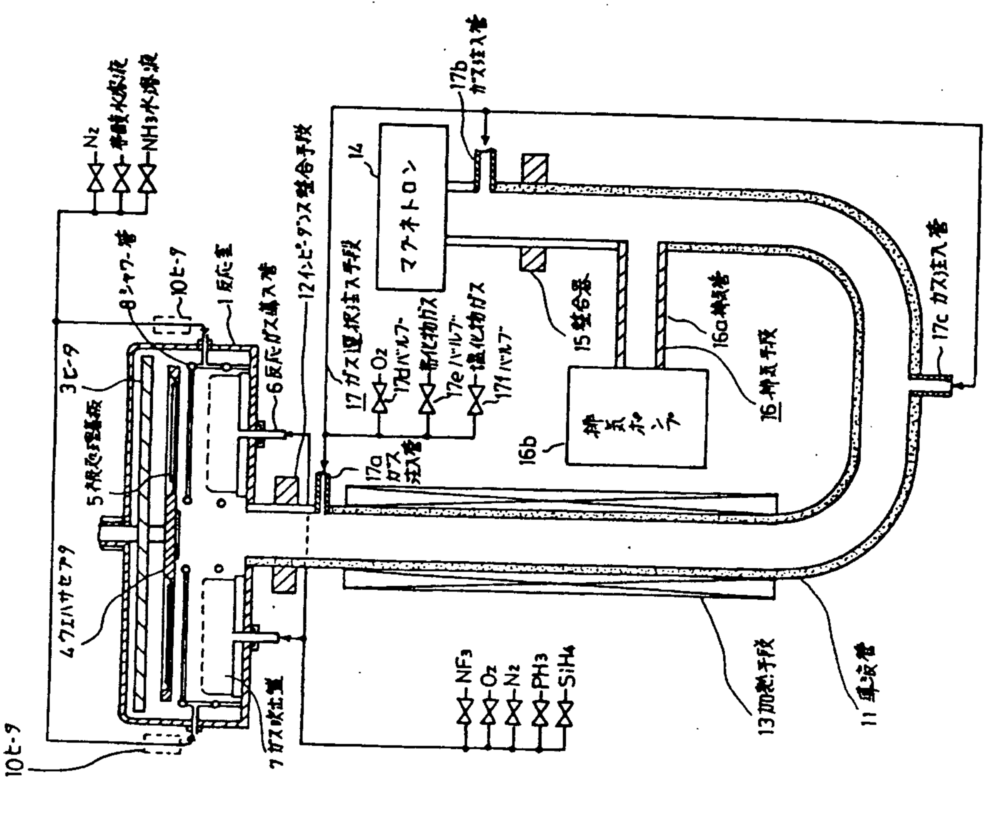
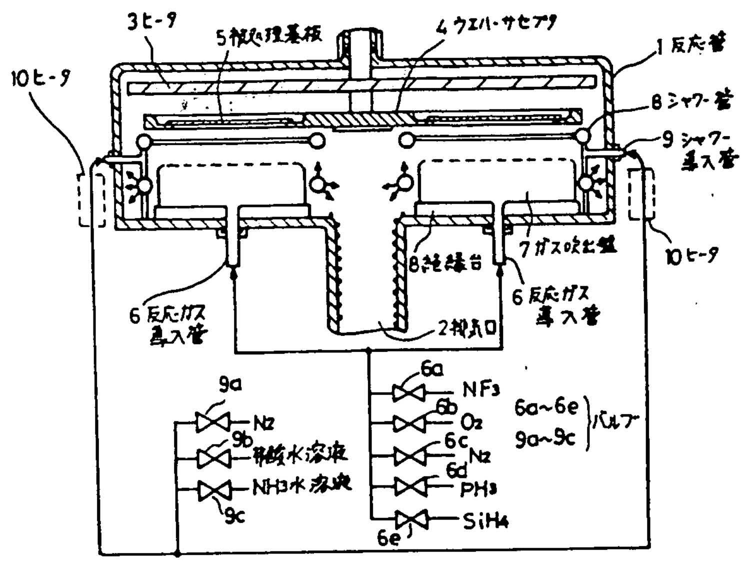
－11－



本発明の実施例の構成を示す要部断面図

第１図



従来のCVD装置の要部断面図

第 2 図

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Specification

1. Title of the invention: Exhaust mechanism for CVD system

2. Claims

(Claim 1) An exhaust mechanism for a CVD system that converts a gaseous substance into a solid substance through a chemical reaction inside a reaction chamber (1), deposits said solid substance as a thin film onto a substrate (5) to be treated, and discharges the residual gas following the aforementioned reaction to the outside of the aforementioned reaction chamber (1); comprised of

a microwave wave-guide (11) that is led to the outside of the aforementioned reaction chamber (1) through the wall of the aforementioned reaction chamber (1),

a heating means (13) for heating said wave-guide (11),

a magnetron (14) connected to the terminal end of the aforementioned wave-guide (11) outside the aforementioned reaction chamber (1), and

an exhaust means (16) linked to the aforementioned wave-guide (11).

(Claim 2) The exhaust mechanism for a CVD system according to (Claim 1), having a gas selection and introduction means (17) for an oxygen gas or etching gas, provided on the aforementioned wave-guide (11).

3. Detailed explanation of the invention

[Overview]

The present invention relates to a CVD system, and more particularly to a mechanism for exhausting gases following chemical reaction inside a reaction chamber,

and the objective of the present invention is to provide an exhaust mechanism for a CVD system, that can remove the residual product inside an exhaust pipe by means of high-frequency cleaning;

and an exhaust mechanism for a CVD system that converts a gaseous substance into a solid substance through a chemical reaction inside the reaction chamber, deposits said solid substance as a thin film onto a substrate (5) to be treated, and discharges the residual gas following the aforementioned reaction to the outside of the aforementioned reaction chamber, is comprised of a microwave wave-guide that is led to the outside of the aforementioned reaction chamber through its wall, a heating means for heating said wave-guide (11), a magnetron connected to the terminal end

of the aforementioned wave-guide outside the aforementioned reaction chamber, and an exhaust means linked to the aforementioned wave-guide.

[Industrial field of application]

The present invention relates to a CVD system, and more particularly to a mechanism for exhausting gases following chemical reaction inside a reaction chamber.

[Prior art]
One of the widely-used methods of forming a thin film in the semiconductor industry is the chemical vapor deposition (CVD) method. In semiconductor manufacturing systems such as the CVD system, after a thin film, etc. of a predetermined thickness is deposited on a substrate to be treated, high-frequency cleaning has been employed to remove the residual product generated inside the reaction chamber, utilizing the plasma generated by a high-frequency oscillator inside an atmosphere of an etching gas, such as a nitrogen trifluoride (NF_3) gas or a mixture of carbon tetrafluoride (CF_4) and oxygen (O_2). Normally, the cycle time for such high-frequency cleaning using a nitrogen trifluoride gas or the like is approximately 1 hour for each hour of film deposition.

Figure 2 is a cross-sectional diagram of the key areas of a conventional CVD system. In this figure, numeral 1 is a reaction chamber, which is a vessel made of stainless components, and an exhaust port 2 is provided on the bottom thereof; this exhaust port 2 is linked to an exhaust pump via an exhaust pipe not shown in the figure. Numeral 3 is a heater, and 4 indicates a wafer susceptor that is rotatably installed, and on which multiple substrates 5 to be treated can be placed.

Numeral 6 is a reaction gas introduction tube, and a number of these gas introduction tubes is provided corresponding to the number of substrates 5 to be treated that can be handled, and gases such as nitrogen trifluoride (NF_3), oxygen (O_2), nitrogen (N_2), phosfine (PH_3), and silane (SiH_4), are introduced via valves 6a through 6e. The reaction gas introduction tube 6 is linked to a gas-injection plate 7 made of aluminum, and the reaction gas introduction tube 6 and the gas-injection plate 7 are insulated from the reaction chamber 1 via an insulation platform 8 made of alumina. The distance between the gas-injection plate 7 and the wafer susceptor 4 is kept to a predetermined value by adjusting the thickness of the insulation platform 8.

For high-frequency cleaning, the output from a high-frequency oscillator (not shown in the figure) is applied using as electrodes the wafer susceptor 4 and the gas-injection plate 7, that is, the electrically connected reaction gas introduction tube 6.

Numeral 8[sic] is a known means of cleaning, which is a ring-shaped shower tube whose wall is provided with a large number of nozzles, which is provided with a function for spraying mist in the directions indicated by the arrows, and which is linked to a shower introduction tube 9 and valves 9a through 9c. Following high-frequency cleaning, nitrogen gas N_2, a water solution of hydrofluoric

acid, a water solution of ammonium, or the like is first heated by a heater 10 and then sprayed from the nozzles, thereby cleaning the interior of the reaction chamber.

[Problems that the invention is to solve]

In conventional high-frequency cleaning, a fair amount of the generated product is adhered to and remains on the areas on the internal wall of the exhaust port 2 indicated by the black dots even after high-frequency cleaning. This residual product acts as a source of particles (fine dust) and becomes the main cause of particle contamination of the substrates (such as wafers) to be treated that are placed inside the reaction chamber.

Furthermore, installing an electrode inside the exhaust port 2 involves the placement of a structure that interferes with the gas exhaust passage, which is not desirable.

The fact that removing the residual product takes a long time results in the problem of a low system-operation rate.

The present invention has been developed in view of the aforementioned problems associated with conventional systems, and its objective is to provide an exhaust mechanism for a CVD system, that can remove the residual product inside the exhaust pipe by means of high-frequency cleaning.

[Means of solving the problems]

Figure 1 is a cross-sectional diagram of the key areas showing the configuration of an embodiment of the present invention. An exhaust mechanism for a CVD system that converts a gaseous substance into a solid substance through a chemical reaction inside a reaction chamber 1, deposits said solid substance as a thin film onto a substrate 5 to be treated, and discharges the residual gas to the outside of the aforementioned reaction chamber 1 following the aforementioned reaction, is comprised of a microwave wave-guide 11 that is led to the outside of the aforementioned reaction chamber 1 through the wall of the aforementioned reaction chamber 1, a heating means 13 for heating said wave-guide 11, a magnetron 14 connected to the terminal end of the aforementioned wave-guide 11 outside the aforementioned reaction chamber 1, and an exhaust means 16 linked to the aforementioned wave-guide 11; an oxygen gas or etching gas is introduced from a gas selection and injection means 17 provided on the aforementioned wave-guide 11.

[Operation of the invention]

The microwave wave-guide 11 provided through the reaction chamber 1 can send microwaves that are output from the magnetron 14 based on the action of a matching means 15. Furthermore, based on the actions of the exhaust tube 16a and the exhaust pump 16b, which comprise the exhaust means 16, the residual gas following a chemical reaction inside the reaction chamber 1 is drawn out

through the wave-guide 11, and the addition of an oxygen gas to this residual gas by means of the gas injection means and heating thereof by the heating means 13 promote the activation of the residual gas; another chemical reaction is then caused by utilizing the plasma generated inside the wave-guide 11 by a microwave, depositing the resulting substance as a thin film on the interior wall of the wave-guide 11, thus preventing flaking. The thin film deposited on the interior wall can be removed by introducing an etching gas, such as a fluoride gas (NF_3 or CF_4) or chloride gas (HCl or PCl_3), from the gas injection means, and at the same time, utilizing the plasma generated by a microwave.

[Embodiment]

An embodiment of the present invention is explained in detail with reference to drawings. Note that in order to make the explanations of the configuration and operation easier to understand, like symbols represent like parts in the drawings, and duplicate explanations are omitted.

Figure 1 is a cross-sectional diagram of the key areas showing the configuration of an embodiment of the present invention. In this figure, numeral 11 is a microwave wave-guide, which is led to the outside of the reaction chamber 1 through its bottom wall, and an impedance-matching means for matching the load between the interior of the reaction chamber and the wave-guide is provided on the part of the wave-guide that is outside the reaction chamber. For example, to keep open the load end of the wave-guide 11 having a transmission impedance of 75 Ω, the impedance-matching means is adjusted to a matching ratio of 300 Ω / 75 Ω.

Numeral 13 is a heating means for heating the gas that comes in from outside and passes through the wave-guide 11, and consists of a heating wire, for example. Numeral 14 is a magnetron connected to the end of the wave-guide 11, and 15 is a matching means for matching the magnetron 14 with the wave-guide 11. Based on the combined actions of the aforementioned impedance-matching means and the matching means 15, the microwave that is output from the magnetron 14 is efficiently transmitted to the interior of the reaction chamber 1.

Numeral 16 is an exhaust means that is linked to a part of the wave-guide 11 that is located between the end of the heating means 13 that is on the magnetron 14 side and the matching means 15, and is comprised of an exhaust tube 16a and an exhaust pump 16b. When the cross section of the wave-guide 11 is rectangular, its smaller side is linked to the exhaust tube 16a such that the gas inside the wave-guide 11 can be drawn out via the exhaust tube 16a by means of the exhaust pump 16b.

Numeral 17 is a gas selection and injection means that is distributed along the wave-guide 11, and is comprised of multiple gas introduction tubes 17a, 17b, and 17c; multiple valves 17d, 17e, and 17f, which make gas selection possible; and pipes connecting these components.

When the heating means 13, the magnetron 14, and the exhaust pump 16b are simultaneously

driven, drawing the residual gas following a chemical reaction inside the reaction chamber 1 into the wave-guide 11, and an oxygen gas is introduced from the gas introduction tubes 17a - 17c by opening the valve 17d, the aforementioned residual gas is activated by a heating effect and by the plasma generated by a microwave. The aforementioned residual then chemically reacts with the oxygen gas again and is deposited as a thin film on the interior wall of the wave-guide 11, thus preventing flaking. Since the interior of the wave-guide 11 is completely hollow and there is nothing that hinders the passage of gases, the thin film can be efficiently deposited.

The thin film deposited on the interior wall of the wave-guide 11 can be removed by introducing an etching gas, such as a fluoride gas (NF_3 or CF_4) or chloride gas (HCl or PCl_3), from the gas introduction tubes 17a - 17c by selectively operating the valves 17e and 17f, and simultaneously driving the heating means 13, the magnetron 14, and the exhaust pump 16b.

The connection position of the matching means 15 and the position at which the exhaust tube 16a is linked to the wave-guide 11 are specified in order to prevent the generated product from adhering to the magnetron 14 and hindering the operation of the matching means.

[Effects of the invention]

As is evident from the above explanation, the present invention has the effect of significantly reducing the particle contamination of the substrate to be treated.

4. Brief explanation of drawings

Figure 1 is a cross-sectional diagram of the key areas showing the configuration of an embodiment of the present invention.

Figure 2 is a cross-sectional diagram of the key areas of a conventional CVD system.

In Figure 1, 1 is a reaction chamber, 5 is a substrate to be treated, 11 is a microwave wave-guide, 12 is an impedance-matching means, 13 is a heating means, 14 is a magnetron, 15 is a matching means, 16 is an exhaust means, and 17 is a gas selection and injection means.

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Figure 1 Cross-sectional diagram of the key areas showing the configuration of an embodiment of the present invention

10: Heater

4: Wafer susceptor
5: Substrate to be treated
3: Heater
8: Shower tube N2
Water solution of hydrofluoric acid
Water solution of NH_3
10: Heater
1: Reaction chamber
7: Gas-injection plate
6: Reaction gas introduction tube
12: Impedance-matching means
17a: Gas injection tube
17: Gas selection and injection means
17d: Valve
17e: Valve
17f: Valve
14: Magnetron
17b: Gas introduction tube
16b: Exhaust pump
15: Matching means
16a: Exhaust tube
16: Exhaust means
13: Heating means
11: Wave-guide
17c: Gas introduction tube

Figure 2 Cross-sectional diagram of the key areas of a conventional CVD system
10: Heater
3: Heater
5: Substrate to be treated
4: Wafer susceptor
1: Reaction chamber
8: Shower tube
9: Shower introduction tube
10: Heater
6: Reaction gas introduction tube
8: Insulating platform
2: Exhaust port
7: Gas-injection plate
6: Reaction gas introduction tube

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N2
Water solution of hydrofluoric acid
Water solution of NH_3

6a-6e
9a-9c Valves